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SOURCE Zhurnal Tekhnicheskoy Fiziki, Vol XX, No 1, 1950, pp 3-26.A SURVEY OF THE ELECTRICAL PROPERTIES OF SILICON

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Introduction

Recently, in connection with the use of silicon and its alloys in the preparation of many different types of detectors, semiconductor amplifiers, and photoresistances, great interest has been shown in the physical properties of silicon, particularly its electrical properties. Information in the literature on the electrical properties of silicon is fragmentary and frequently contradictory. Therefore, it is thought expedient to outline here the basic data now known on silicon, mainly from the viewpoint of the modern theory of the nature of electrical properties in solids.

Nature of Electrical Conductivity in Silicon.

Gives historical discussion of Seeman, Wilson, Guden, Schulze's work on the dependence of silicon's specific resistance upon temperature.

Crystalline Structure of Silicon and Nature of its Energy Zones

Considers the width of the forbidden zone:

$$\Delta W_n \approx \frac{2e^2}{\pi^2 \hbar^3} (Z - f_n) |S_n|,$$

where  $e$  is the electron charge,  $Z$  the atomic number,  $\hbar$  the atomic distance factor,  $n$  the totality of indexes of a given grain,  $d$  the lattice constant, and  $S_n$  the structural factor. Thus  $\Delta W_{\text{exp}} \approx 2.6$  ev, according to foreign references.

Electrical Conductivity of Pure Silicon, and its Dependence on T

Considers the formulas:

$$\sigma = A_1 \cdot \exp(-B_1/T) + A_2 \cdot \exp(-B_2/T)$$

where  $B_1 = \Delta W_1/k$  and  $B_2 = \Delta W_2/k$ ; and

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$$\sigma = n_0 e \mu \exp(-\Delta E_i / 2kT)$$

where  $n_0$  is the number of local levels of the admixture, and  $\mu$  is the electron's mobility in the conduction zone, as given in the literature.

#### Electrical Conductivity of Certain Solid Solutions of Silicon

Compares silicon solutions containing admixtures of boron, phosphorus, aluminum, etc., relative to the concentration of charge carriers and quantity of admixture, as given by Torrey and Whitmer,

#### Measurements of Hall's Constant in Pure Silicon and in Silicon With Admixtures of Other Elements; Concentration of Charge Carriers and Their Mobility

Includes the data of Pearson, Bardson, Torrey, Whitmer, and the author.

#### Thermoelectromotive Force of Silicon

Compares the following thermocouples: Si-Pb, Si-Bi, Si-Sb, Si-Te, Si-Se, Si-SiC, Si-Pt, Si-C, SiC-BE, Si-constantan, from the data of Week and Ellis.

#### Practical Use of Silicon in Semiconductor Techniques

Considers thermo-emf versus T, and the spectral characteristics of photoresistors obtained by the pyrolytic deposition of silicon on porcelain.

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